

PHILIPS



Manual

(refer also to basic PM 3250/04 manual)

Dual trace storage oscilloscope **PM 3251**



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I. Introduction

Operating manual

The PM 3251 (storage version of the dual-trace 50 MHz general purpose oscilloscope PM 3250) is equipped with a PHILIPS post-accelerator half-tone storage tube type L14-110GH.

The service life of this tube is comparable to that of a conventional c.r.t. assuming that the tube is not used at too high intensities over extended periods of time.

Waveforms are stored in the PM 3251 by using a conventional electron gun assembly to form a charge pattern on the surface of a storage layer. This pattern can be maintained for a considerable period of time, even when the apparatus has been switched off.

The length of time that a stored image remains displayed depends upon the degree of display brightness used, and can be longer than two hours. It is possible to store several single-shot waveforms in order to display them simultaneously. An erase facility enables stored information to be cancelled at will.

The PM 3251 also incorporates a feature which enables display persistence to be varied over a wide range. This enables a stable display of repetitive slow-speed signals to be displayed without flicker effects. The variable persistence feature also enables fast h.f. signals to be displayed. In this case, several cycles are used to develop the image on the memory layer so that a clear display can be obtained. Such displays may be obtained using signals with repetition rates as low as one cycle per minute. Single-shot signals which are normally too fast for display by a conventional oscilloscope may be written by means of a 'max write' facility. Because of the high degree of sensitivity involved in this mode of operation, display quality is slightly degraded.

In addition to the storage and variable persistence modes, the PM 3251 may be operated at the normal persistence of the P31 screen phosphor.

The performance of the oscilloscope is exactly the same as the basic PM 3250.

The majority of electrical and mechanical units fitted to the PM 3251 are fully interchangeable with those of the PM 3250.

Both oscilloscopes share a common technical specification, with the exception of the PM 3251 storage and variable persistence features.

II. Specification

Properties expressed in numerical values with stated tolerances are guaranteed for nominal mains voltages. Numerical values without tolerances merely serve as a guide and represent the characteristics of an average instrument.

The remainder of the data is as stated in the PM 3250 manual.

DISPLAY

Cathode ray tube	Post-accelerator, half-tone storage tube. 8 kV accelerating potential and P31 phosphor. Internal graticule.
Persistence (normal mode)	10 μ s to 1 ms (i.e. natural persistence of P31 phosphor).
Persistence (variable mode)	From less than 0,3 s to more than 10 min.
Graticule	8x10 div. internal graticule (1 div. = 0,9 cm)

STORAGE

Storage time (dark, but switched-on)	Greater than 4 hours
Storage time (minimum visible brightness)	Greater than 2 hours
Storage time (maximum brightness)	Greater than 10 min.
Writing speed (variable persistence mode)	Greater than 100 div./ms
Writing speed (Max. write mode)	1,2 div./ μ s
Erasure	Push-button enables erasure to be made in 600 ms approx.

III. Description of the block diagram

A. MAIN MULTIVIBRATOR

The main multivibrator produces a 2-kHz-square-wave signal which is used to drive the flood-gun and persistence control circuits.

B. FLOOD-GUNS CONTROL CIRCUIT

The flood-guns control circuit includes a variable-duty multivibrator which is controlled by the storage brightness potentiometer R18A.

Square-wave pulses are passed to the flood-gun accelerators when the oscilloscope is in the STORE mode, and this acts as the display brightness signal (See Fig. 3). In the variable-persistence mode, the control circuit holds the flood-gun accelerators at a constant level.

C. VARIABLE-PERSISTENCE CONTROL CIRCUIT

The variable-persistence control circuit enables a series of automatic erasure pulses to be fed to the storage mesh in order to extend the display persistence (See Fig. 4). The duty cycle of the automatic erasure pulses (and hence the amount of persistence) is determined by potentiometer R18B.

D. ERASE CIRCUIT

The erase circuit is used to generate one discrete erasure cycle (See Fig. 5) when the ERASE button is operated. This circuit is only operable provided that the oscilloscope is in its variable-persistence mode.

E. WRITE CONTROL CIRCUIT

The write-control circuit is used to cut off the writing gun automatically during erasure and storage display periods.

F. MAX WRITE CIRCUIT

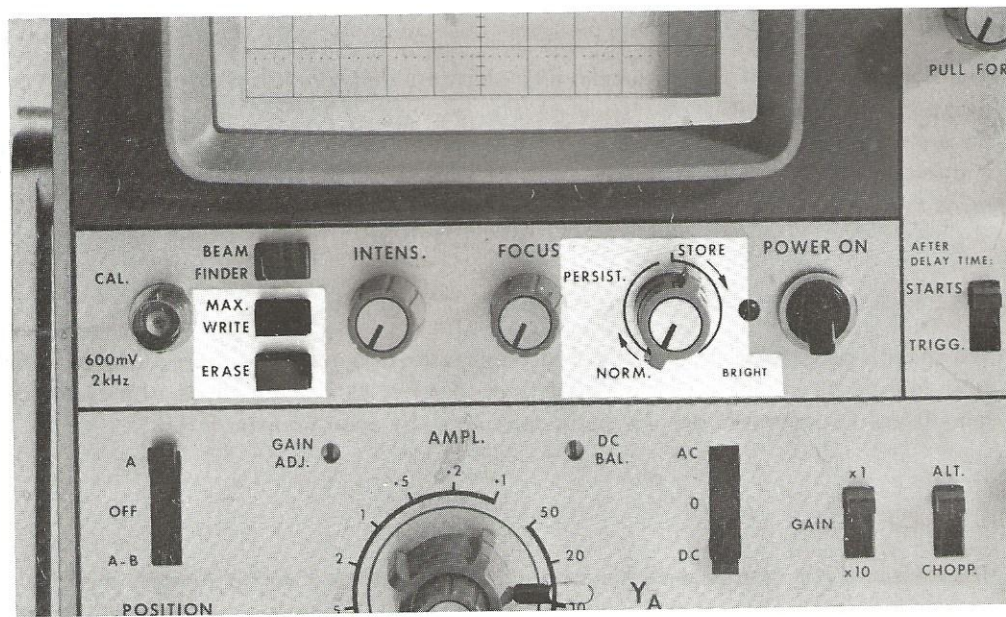
The max write circuit provides means by which the erase-cycle pulse can be modified in amplitude. The change in amplitude results in the memory mesh becoming extremely sensitive so that very fast single-shot signals may be displayed.

IV. Operating instructions

Directions for use

With the exception of the typical persistence and storage controls which are explained later, reference has to be made to the chapter 'Operation' in the Manual of the basic PM 3250 version.

INTRODUCTION



MAX. WRITE : Press to increase the writing speed by a factor of approx. 10 (some background is shown on the display)

ERASE : Press to erase the displayed signal (only operative in 'PERSIST.' mode)

NORMAL : Operation as basic PM 3250 version

PERSIST. : The persistence of the display is adjustable in this range. By turning the knob clockwise the persistence is increased.

STORE : A display obtained in the 'PERSIST.' mode can be stored by turning the knob to the 'STORE' range. By turning the knob clockwise in this range the brightness of the stored display is increased.

*Storage - option.
Blooming - also blooming
ATE
erase - written*

GENERAL

CAUTION:
EXTENDED HIGH INTENSITY MAY DAMAGE CRT.

The storage CRT is of a rugged type and is not easily damaged. However, a high intensity repetitive trace or signal (or point), written for an extended time may penetrate into the storage mesh layer and cause permanent damage.

In the 'Variable-Persistence' mode the CRT itself warns that the intensity is too high by 'blooming'. When 'blooming' occurs intensity should be turned back.

As such indication does not occur in the 'Normal' mode, special care should then be taken.

Use as a normal oscilloscope

Set the PERSIST.-STORE control knob to position: NORMAL.

Variable persistence

With the control knob in the PERSIST. range a certain persistence of the display is obtained.

The duration of the persistence is increased by turning the knob clockwise in the PERSIST. range (the green overall haze showing at short persistence settings does not influence the correct operation of the cathode ray tube).

Depending on the persistence setting, the intensity must be controlled to avoid 'blooming' by the display.

When displaying a low-frequency signal, the persistence can be set to suppress any flickering of the display.

When a signal with a low repetition rate and a short rise-time is displayed, the persistence can be set in order to fill up the trace so that a clear, steady display is obtained.

When single-shot phenomena are displayed, the persistence control knob must be turned fully clockwise in the PERSIST. range.

Some trial settings of the INTENS. and FOCUS knobs may be necessary to obtain optimum writing speed in the Persist. and Max. Write mode (in fact the writing beam of the c.r.t. should be focussed on the storage mesh).

With the SET READY push-button as well as with the ERASE push-button, it is possible to set the time-base circuit for a single shot.

Several single-shot phenomena can be displayed below each other, when the POSITION control is set to a different position after each shot (the dial printings near the POSITION controls are not calibrated; they serve only for general information).

Max. write

The writing speed can be increased by a factor of approx. 10 by pushing the MAX. WRITE button (normally required only for short sweep times).

The Max. write mode only functions when the ERASE button is pressed after operation of the MAX. WRITE button.

Erase

A display is erased by pressing the ERASE button (only when the control knob is in the PERSIST. range).

If too high intensities have been used it may be necessary to keep this button pressed for several seconds to obtain an ultimate 'cleaning' of the storage layer.

Store

A display obtained in the PERSIST. mode can be stored by turning the control knob to the STORE range (now the writing gun of the cathode-ray tube is switched-off).

The brightness of the stored display is increased by turning the knob clockwise; however, the storage time is limited at higher brightness levels (see 'Specification').

When the mains voltage of the oscilloscope is switched-off, the display remains stored (without showing) for at least several days.

Note, that switching on the instrument when the cathodes of the c.r.t. are still warm, disturbs the stored display (so wait at least 5 minutes).

V. Circuit description

Service manual

A. INTRODUCTION

This section of the Appendix describes the various control and display circuits which are exclusive to the PM 3251 storage oscilloscope. The section also details those modifications which have been made to PM 3250 circuits in order to make them suitable for the PM 3251.

Most of the additional circuitry for this storage version has been located on the storage control unit, fixed over the time-base units and on the flood-gun filament supply unit, mounted behind the vertical output amplifier unit.

The main circuit description is preceded by an explanation of the memory tube, as this will assist the reader to understand the function of the various control circuits.

B. STORAGE C.R.T.

The PHILIPS storage c.r.t. type L14-110GH contains a writing system which comprises an electron gun and deflection electrodes which are identical with those of a conventional cathode-ray tube.

The memory tube also houses two flood-gun assemblies which are mounted just forward of the deflection plates, an electrostatic collimator, and storage and collector meshes which are located near the screen.

As in a normal professional cathode-ray tube, the screen phosphor is metallized in order to allow a post-accelerator potential of 5,6 kV to be applied.

The rear (cathode) side of the storage mesh is coated with magnesium fluoride, a material with excellent insulation and secondary emission properties. When this material is struck by electrons of an energy exceeding 40 electronvolts, its secondary emission ratio is higher than 1 (which means that a higher number of electrons is emitted than the number arrives). A relatively-positive charge pattern can therefore be built up by the writing gun and maintained on the surface of the magnesium fluoride. This positive charge pattern can be used to admit electrons to the screen phosphor and so reproduce the stored waveform on the screen.

Since magnesium fluoride is an insulator, a capacitive coupling is formed between the charge pattern present at the surface layer and the metal of the storage mesh. This capacitive property enables a stored pattern to be erased and the mesh to be prepared prior to the storage of a new pattern.

Immediately prior to recording a waveform, the whole surface layer of the storage mesh is brought to a uniform negative potential by means of an erase cycle. The conventional writing system is then used to write the required waveform on the storage mesh.

The path on the storage mesh traversed by the electron beam is charged to a potential which approaches zero volts: this relatively-positive image area allows electrons to be attracted by the high potential on the screen layer. The remaining (negatively charged) areas of the storage mesh repulse the flood-gun electrons so that they may be taken by the collector mesh.

The collector mesh, situated at the rear (cathode) side of the storage mesh, is held at a positive potential of 100 V.

This positive potential serves to accelerate electrons towards the storage mesh and also to capture those electrons which are repelled.

The two flood-gun assemblies, located just forward of the conventional deflection plates, are used to emit sprays of low-energy electrons.

The collimator, which consists of graphite deposit on the sides of the tube glass, is used to form the flood-gun electrons into an evenly-distributed stream in order to obtain an even display. The stream is accelerated towards the screen by the collector mesh whose apertures are of the same size as those of the memory mesh.

Having passed through the storage mesh, the electrons are further accelerated by the post-accelerator potential (5,6 kV) on the metallized screen layer.

C. FLOOD-GUN ACCELERATORS CONTROL CIRCUIT

When the oscilloscope is operating in the STORE mode, the flood-gun accelerators are supplied with a variable pulse-width signal which controls the display brightness, see Fig. 3. The flood-gun control circuit (see Fig. 8) includes a variable duty-cycle multivibrator (TS1903, TS1904, TS1906 and TS1907) which is

driven by a 2-kHz-signal obtained from the main multivibrator (TS1901 and TS1902). The percentage duty cycle is determined by potentiometer R18A, and the resulting signal is used to provide display brightness in the storage mode.

A positive pulse coming via GR1901 causes TS1904 to conduct whilst the remaining three transistors of the variable-duty cycle multivibrator are cut off. After a period of time (determined by the setting of R18A) TS1903 is returned to its conductive state and TS1904 is cut off.

The collector level of TS1904 is then determined by the voltage across C1903, R18A and R1918; this level sets the point at which TS1906 and TS1907 are switched on. In the event of a positive pulse appearing at the base of TS1904 before TS1906 and TS1907 switch on, the previous cycle is overridden. The circuit operation therefore provides continuous selection of the duty cycle from 1 % to 100 %.

The output of the variable-duty cycle multivibrator is inverted by TS1908, and is then used to control the emitter follower TS1909 which supplies the flood-gun accelerators. An emission of electrons takes place whenever the output of TS1909 becomes positive with respect to the flood gun cathode.

If the switch SK31 is moved from its STORE position, the +12 V supply is removed from the base of TS1908. This results in TS1908 being cut off.

The variable duty-cycle waveform is consequently blocked and emitter follower TS1909 supplies a continuous level which is positive with respect to the flood-gun cathodes. An uninterrupted stream of electrons is therefore emitted in both 'Normal' and 'Variable Persistence' modes.

D. WRITE CIRCUIT CONTROL

When a stored waveform is being displayed, it is important that no further displays are written on the memory mesh inadvertently. In order to prevent this, the conventional writing system is disabled.

With switch SK31 set to its STORE position, a +12 V supply is connected via GR1918 and GR1968 to the base of TS1918.

Consequently, transistors TS1918 and TS1919 conduct and a current is fed to the write circuit to cut off the writing gun.

If an erase cycle is initiated by closure of the ERASE switch SK30, the writing gun is disabled by a current supplied to the base of TS1918 by way of GR1917 and R1966.

Upon release of the ERASE switch, a 600-ms-pulse is applied to the base of TS1918 (via GR1916 and R1962) to hold the writing circuit in its disabled condition until the conclusion of the erase cycle (see para F).

E. VARIABLE PERSISTENCE CONTROL CIRCUIT

When switch SK31 is set to its PERSIST. position, potentiometer R18B may be used to vary display persistence over a range of from less than 0.3 sec. to more than 10 min. This persistence control is obtained by using a series of pulses in order to periodically 'wipe' the written signal from the memory mesh.

The wiping pulses are derived from the 2-kHz-square-wave output of the main multivibrator, which also drives the flood-gun anode control circuit. The square-wave signal is fed via TS1911 to a variable integrator circuit (C1904, R1934, R18B). The integrated signal is used to switch transistor TS1912, the cut-off periods of which are dependent upon the setting of R18B. Pulse amplitude set by trimmer R1944 (R1946 in the MAX WRITE mode).

The wiping pulses are brought to a -50 V level by means of the clamping circuit (C1906 and GR1911) and are then applied to the storage mesh.

F. MANUAL ERASE CYCLE

Operation of the ERASE switch SK30 results in the application of a 100 V potential to the storage mesh, provided that switch SK31 is in its PERSIST position. At the same time a d.c. potential is applied to diode GR1914 causing capacitors C1907 and C1908 to charge.

Immediately upon release of switch SK30, capacitors C1907 and C1908 discharge, causing TS1916 to produce a pos. 600-ms-pulse and TS1917 a pos. 200-ms-pulse. The pos. 600-ms-pulse is inverted by TS1914 prior to being applied, together with the 200-ms-pulse, to TS1913. Transistor TS1911 is maintained in a bottomed condition throughout the 600-ms-period via R1939, so that the 2-kHz-square-wave input to the variable persistence circuit is interrupted. Normally, TS1913 is bottomed by the base current flowing via R1943 and GR1908. During this erase period, TS1913 conducts for 200 ms, and is switched off for the remaining 400 ms. Transistor TS1912 is then also switched off and its collector level rises to approximately 10 V.

The resulting erase cycle, illustrated in fig. 5, firstly destroys any data which may be stored on the memory mesh by bringing its surface layer to a potential of 100 V. When the button is released, the surface potential falls towards zero volts. After 200 ms, the storage mesh is raised to 10 V and is maintained at that level for a further 400 ms.

The surface layer consequently follows, due to capacitive coupling, and is raised to 10 V, but there is an immediate decay in the surface layer potential due to the reception of flood-gun electrons.

Because of this, the trailing edge of the erase cycle waveform causes the surface layer to be reduced to a negative 10 V. The erase cycle is then complete and the memory mesh is fully prepared to accept a new waveform for storage.

During the erase cycle a positive 25 V (approx.) pulse of 400 ms is also added to the normal collimator voltage.

G. MAX WRITE MODE

As stated in the previous paragraph, the memory mesh surface potential is -10 V immediately after the erase cycle. The conventional electron gun assembly which is then used to write a fresh waveform must charge the surface to a storage threshold of approximately -5 V if the stored information is to be written on the screen. If the written waveform does not charge the surface to a sufficient potential (-5 V) the flood-gun electrons will not be attracted by the post-accelerator potential at the screen layer.

Operation of the MAX WRITE switch causes R1946 to be connected between earth and the collector of TS1912. This reduces the amplitude of the erase cycle waveform by approximately half the original value. After erasure in the MAX WRITE mode, the memory mesh surface potential is raised to almost the threshold level. Writing speed is consequently increased significantly for fast single-shot signals. This mode of operation degrades the contrast quality (because flood-gun electrons may penetrate the memory mesh) so that it is only suitable for very fast single-shot recording processes.

H. NORMAL OPERATION

With switch SK31 set to NORMAL, the oscilloscope may be operated as a conventional instrument. For this purpose, a -90 V potential is connected to the memory mesh via the contacts of switch SK31. The electrons emitted from the flood-guns are too slow to be accelerated through the meshes, whereas the relatively fast electrons of the writing system may be passed through to the screen layer.

VI. Checking and adjusting

GENERAL

This chapter provides the checking and adjusting procedure for the specific PM 3251 functions.

For the remaining functions refer to chapter 'Checking and Adjusting' in the basic PM 3250 manual.

Because some of the circuits are interdependent, a certain order of checking and adjusting is often required.

The procedures are, therefore, presented in a sequence which is best suited to this order and cross-reference is made to any circuit which may influence a particular adjustment. Prior to checking and adjusting a particular circuit, care must be taken to ensure the accuracy of all associated circuits.

The tolerances stated in the checking and adjusting procedures apply only to instruments which are completely adjusted, and may differ from the data given in chapter on SPECIFICATION in this manual. Only skilled personnel familiar with the risks of shock should carry out adjustments which necessitate the removal of covers from an oscilloscope which is connected to the mains. In all other circumstances, covers should remain fitted as long as the instrument is live.

Check that the position of the voltage selector at the rear of the instrument corresponds to the local mains voltage (check also that mains fuse has the correct value).

In general a preliminary warming-up time of at least one hour is recommended.

Before checking or adjusting any circuit be sure that the instrument is in reasonable working condition.

After adjustment of preset potentiometers do not forget to refit the dust caps.

All preset potentiometers, select-in-test resistors and trimming capacitors are indicated in Fig. XI-8 and Fig. 6 of this Appendix.

All controls mentioned in the 'checking and adjustment' procedure without item number are located on the front panel.

Unless otherwise stated, the front panel controls must set to the following positions:

- PERSIST.-STORE knob in position "Minimum Persistence" (against Normal position).
- Trigger switches of the main time-base to positions: AUTO, Y_A , LF and +.
- MAIN TIME-BASE switch to 1 ms/div. (cont. control to CAL.).
- X DEFL. switch to MAIN TB.
- DELAY TIME multiplier to 0.
- Trigger switches of the delayed time-base to: STARTS, Y_A , LF and +.
- DELAYED TIME-BASE switch to OFF (cont. control to CAL.).
- GAIN switch to: x1.
- CHOPP./ALT. switch to: ALT.
- Both AC/0/DC switches to: AC.
- Switch A/OFF/A–B to A.
- Switch B/OFF/–B to OFF.
- The ERASE button must be pressed to engage in the variable persistence mode, after each (trial) adjustment.

When the C.R.T. has been replaced, check (and adjust) in the next order:

- Supply voltages, chapt. A.
- Variable persistence, chapt. C1.
- C.R.T. circuits, chapt. B.
- Writing speed, chapt. C2.

A. SUPPLY UNIT

Only the +24 V and -24 V voltages and the c.r.t. flood-gun filament voltage of the supply unit are adjustable.

Required instruments:

- A mains voltage meter
- A d.c. measuring instrument
- For checking the stabilisation properties of the supply unit, a variable transformer (100 VA) and a high-sensitivity voltmeter (preferably a digital voltmeter) are required.

Supply voltages

Supply voltage	Tolerance	Test point	Max. perm. ripple voltage
+ 24 V	$\pm 2 \text{ ‰}$	Terminal board, red lead ¹⁾	2 mV _{p-p}
- 24 V	$\pm 2 \text{ ‰}$	Terminal board, yellow lead ¹⁾	2 mV _{p-p}
+ 12 V	$\pm 0,5 \text{ V}$	Terminal board, blue lead ¹⁾	2 mV _{p-p}
- 12 V	$\pm 0,5 \text{ V}$	Terminal board, grey lead ¹⁾	2 mV _{p-p}
+ 22,2 V	$\pm 0,1 \text{ V}$	Emittor TS1210 Power supply U7	—
6,3 V	$\pm 0,1 \text{ V}$	Across R1278 Flood-gun unit U38	—
+ 90 V	$\pm 3 \text{ V}$	Terminal board, purple lead ¹⁾	0-0,5 V _{p-p} depending on sweep times
- 90 V	$\pm 3 \text{ V}$	-C1308 unit U3, rear side of board	0-0,5 V _{p-p} depending on sweep times
+198 V	—	+C1211, orange lead ²⁾	1 V _{p-p}
-198 V	—	-C1208, white lead ²⁾	1 V _{p-p}

¹⁾ Test points on terminal board, located underneath the c.r.t., and behind the delay line and unit U9.

²⁾ See Fig. XI-1.

Adjusting the +24 V and -24 V

For test points see table above.

Adjust R1208/U2 for +24 V ($\pm 2 \text{ ‰}$).

Adjust R1242/U2 for -24 V ($\pm 2 \text{ ‰}$).

C.r.t. flood-gun filament voltage

Adjust R1276/U38 until this voltage is 6,3 V ($\pm 0,1 \text{ V}$).

High voltage chopper supply voltage

The emittor voltage of TS1210/U7 must be 22,2 V ($\pm 0,1 \text{ V}$) with respect to earth.

If necessary change R1270.

Mains voltage influence

Vary the mains voltage + and -10 % of the nominal value using a variable transformer; the +24 V and -24 V supply variation should be less than 1 ‰.

Power consumption

Check that the mains current at 220 V mains voltage, 50 Hz amounts to 600 ... 700 mA (use a soft-iron meter only).

B. CATHODE RAY TUBE CIRCUIT

Introduction

In this chapter following checks and adjustments are discussed:

1. Intensity R1742/U9, R1743/U9, (R6).
2. Unblanking (Z-amplifier), C1708/U3, C1709/U3, R1733/U3, (R1321/U3).
3. Focus and Astigmatism R1337/U9, R1758, (R7).
4. Trace rotation, Orthogonality and Pattern distortion R1773, R1772, R1769, R1752.
5. Gain and h.f. response of the vertical amplifier.
6. Gain and linearity of the horizontal amplifier and the time-base.

If necessary, first check the variable persistence adjustment, chapter C.1.

Required instruments

- A sine-wave generator (2 kHz).
- A d.c. voltmeter.

1. Intensity

The control range of the INTENS. knob on the front panel is adjusted with R1742 (–) and R1743 (+) located on calibration unit U9.



Warning: Use a well-insulated trimming tool as these potentiometers carry 1600 V.

- Set the PERSIST-STORE knob to position "Minimum Persistence" (against Normal position).
- MAIN TIME-BASE switch to 1 ms/div.
- DELAYED TIME-BASE switch to 1 μ s/div.
- No signals on the Y-inputs.
- A/OFF/A–B switch to A.
- B/OFF/–B switch to B.

Avoid too high intensities in following procedure when the X DEFL. switch is switched to the EXTERN position.

- DELAY TIME Multiplier in middle position (5.00).
- Rotate INTENS knob on the front until it is 90° from its fully anti-clockwise position.
- X DEFL. switch to EXTERN.
- The spot must now be just visible; if necessary adjust R1742 and FOCUS knob.
- X DEFL. switch to DEL'D TB.
- INTENS knob fully clockwise.

The dot at the beginning of the trace must be just visible; if necessary adjust R1743.

Repeat for optimum results.

2. Unblanking (Z-amplifier)

Equal brightness of the trace is adjusted with C1708, C1709, R1733 (R1730).

- MAIN TIME-BASE switch to .05 μ s/div.
- X MAGN switch to x5 (knob pulled out).
- DELAYED TIME-BASE switch to OFF.
- PERSIST.-STORE knob to position "Normal".

The trace must be of equal brightness throughout; if necessary, adjust C1708 and C1709. Any irregularity can best be seen at low brightness.

- When the INTENS knob is turned from max. brightness to the intensity at which the trace is just visible, the beginning of the trace may not shift more than 20 ns (= 2 div.).

If necessary, readjust C1708 and C1709.

- X MAGN switch to x1 (push knob).

In every position of the MAIN TIME-BASE switch there may not be a bright dot at the beginning of the trace.

If necessary change R1730.

- MAIN TIME-BASE switch to 2 ms/div.

- Rotate INTENS knob until the trace is just visible.
The trace must be equally bright over the whole length. If necessary adjust R1733.
- PERSIST.-STORE knob to position "Minimum Persistence" (against the Normal position).
- Check the INTENS control range, para 1. again.
If necessary readjust R1742 and R1743.
- X DEFL. switch to MAIN TB.
- Trigger selector switch to SINGLE.
- MAX. WRITE button not pressed in.
- PERSIST.-STORE knob to position "Maximum Persistence" (against store range).
- INTENS knob fully clockwise.
- Position the dot on the screen.
- Rotate FOCUS knob for optimum sharpness.
- The dot may not bloom up in Normal- and in max. write mode; if necessary turn R1743 somewhat clockwise.

3. Focus and Astigmatism

Focus and astigmatism are adjusted in the "Minimum Persistence" setting (against Normal), with R7 (front panel) and R1758 (centre mounting plate) respectively.

- Apply a 2-kHz-sine-wave signal to input Y_A .
- Set the Y_A AMPL. switch for a six-divisions peak-peak vertical deflection.
- Set the INTENS knob on the front to low brightness.
The display can be focussed with the front panel FOCUS control to obtain a reasonably sharp clearly-defined trace.
- If necessary adjust R1758 in conjunction with the FOCUS knob.
- If the FOCUS knob is now far from its middle position, change R1748/U9.
- Check also whether the display can be focussed at higher brightness settings.

4. Trace rotation (R1773), Orthogonality (R1769, R1772) and Pattern distortion (R1752)

These potentiometers are located on the centre mounting plate

- Both AC/0/DC switches to 0.
- Measure the output voltage of the vertical output amplifier (test points 4 and 6 in Fig. XI-4).
- Adjust the Y_A POSITION knob at the front until this voltage is 0 volt (if the POSITION control is not now in its middle position, the vertical amplifier must be checked).
- The trace must now be exactly on the central horizontal graticule line.
If not, R1773, R1769, R1772 and R1752 must be adjusted; first set these potentiometers to their middle position.
- Adjust R1773 to obtain an exact horizontal trace, and adjust R1769 and R1772 so as to locate this trace exactly on the central horizontal graticule line (rotate R1769 and R1772 one as much as the other).
- Remove the voltmeter but keep the Y_A POSITION knob in the same position.
- AC/0/DC switch of the Y_A channel to AC.
- Apply a 2-kHz-sine-wave signal of 2 V_{p-p} to the Y_A input.
- Y_A AMPL. switch to 20 mV/div.
- Adjust R1769 and R1772 so, that the lines in the middle of the display stand exactly vertical.
- AC/0/DC switch to the Y_A -channel back to 0 and readjust R1773, R1769 and R1772.

Repeat this complete procedure several times for optimum results (check that the output voltage of the vertical output amplifier is 0 volt when the AC/0/DC switch is in the 0 position).

- Adjust R1752 until the outer left and right lines of the display are as straight as possible.

5. Gain and h.f. response of the vertical amplifier

Refer to chapter D.6. *)

6. Gain and linearity of the horizontal amplifier and the time-base

Refer to chapter H. *)

*) of chapter CHECKING AND ADJUSTING basic PM 3250 (/04) manual.

C. VARIABLE PERSISTENCE AND WRITING SPEED

Introduction

All adjustment controls are located on the p.c. board (U40) which has been mounted above the time-base p.c. boards.

Remember to **press the Erase button** in the variable persistence mode after every (trial) adjustment.

Required instruments

Oscilloscope (any type).

Sine-wave generator (1 kHz - 12 kHz; 1,6 V_{p-p}).

1. Variable persistence

- "Persist.-Store" knob to "Minimum Persistence".
- R1765 in mid position.
- R1986 in mid position.
- Adjust R1754 until the voltage across R1756 is 400 to 450 mV.
- Adjust R1767 until the voltage across R1764 is 400 to 450 mV.
- "Max. Write" button not pressed.
- "Intensity" knob to minimum intensity.
- Connect an oscilloscope to the "+" side of C1906 (see Fig. 6).
- The pulses on this point must have just disappeared when the "Persist.-Store" knob is turned to its maximum-persistence position. If necessary change R1934.
- The manual erase pulse can also be checked on this point.

"Persist.-Store" knob to max. persistence.

When releasing the "Erase" button the erase pulse must show (600 ms $\pm$ 5 %). See Fig. 5.

If necessary change R1957 for correct pulse duration.

- * – "Pers.-Store" knob to its "Minimum-Persistence" position.
- "Max. Write" button not pressed.
- Adjust R1977 so that just no rim effects are visible on the screen (rotate R1977 from CCW position up for equal screen luminisence). See photographs 1 and 2.
- Press "Max. Write" button.
- Adjust R1976 so that it is visible that there are just no rim effects on the screen.
- "Max. Write" button not pressed.
- "Pers.-Store" knob to its "Maximum-Persistence" position.
- Adjust R1944 so, that the screen just remains dark (just-black level).
- Press "Max. Write" button.
- Adjust R1946 for best overall mesh definition.
- Adjust R1765 so that both clouds have the same brightness.
- Adjust R1986 so that both clouds reach as much screen surface as possible and obtain equal cloud distribution over the screen. See photograph 3.

(Repeat above procedure from * on for optimum results, combined, if necessary, with writing-speed check dealt with in next para).

In the 'Variable persistence' mode a ringing sound could sometimes be heard from the c.r.t. (caused by resonance effects of the meshes near the screen of the c.r.t.). This can be suppressed by changing R1260 (560 k ... 1,2 M ohms).

2. Writing speed

Abstract from specification Writing speed.

Normal : 100 div./ms

Max. write mode: 1,2 div./ μ s

For optimum results (or, e.g. if the c.r.t. has been replaced) first check the c.r.t. circuit adjustments chapter B.

a. Definition

The writing speed is the maximum speed of the electron beam in X- or Y-direction on the screen in single-shot mode in which the written line is visible.

The lines of the pictures obtained must be clearly visible in Normal writing mode as well as in Max. write mode.

Some divisions at the rim of the screen may be partly or entirely not written (the written surface of the screen must be as symmetrical as possible).

The number of not-written divisions may not be more than 16, viz. 20 % of the whole screen surface.

b. Checking

The writing speed as given in the specification is checked as follows:

- Button Max. Write not depressed.
- Apply a sine-wave signal of 1 kHz at a Y-input.
- Set main time-base switch to 2 ms/div.
- Set Norm.-Persist.-Store knob to position "Minimum Persistence".
- With the input attenuator adjust the amplitude of the input signal in such a way that a picture height of 32 divisions (peak-to-peak) is obtained.
(To this end first set the input attenuator to position .2 V/div. and adjust the picture height to 8 divisions by varying the input signal; then set the input attenuator to position 50 mV/div.).
- Trigger, focus and centre the picture obtained.
- Set trigger switch to position "Single".
- Set Norm.-Persist.-Store knob to position "Maximum Persistence" (near position Store).
- Knob Trigger level pulled and turned fully clockwise.
- Intens. fully clockwise.
- Push Erase button shortly.
- Turn knob Trigger level anti-clockwise until a picture is obtained. See photographs 4 and 5.
- If necessary repeat and adjust the focussing *) to maximum (knob Trigger level turned fully clockwise, Erase button pushed slightly and knob Trigger level turned anti-clockwise).

For checking in Max. write mode the operation is the same but:

- Push button Max. write.
 - Frequency of the input signal 12 kHz.
 - Set main time-base switch to .2 ms/div.
- See photographs 6, 7 and 8.

*) In fact the electron beam should be focussed on the storage mesh layer to obtain optimum writing speed.

c. Calculation

The vertical deflection is 32 divisions as mentioned under *b* above.

The path described by the electron beam is then $16 \text{ div.} \sin \omega t$ (ω being the circle frequency of the input signal).

The speed of the beam in the vertical direction is thus $16 \omega \cos \omega t$ (the speed in horizontal direction is negligible).

For the visible part of the sine wave, $\cos \omega t = 1$ may be assumed.

The writing speed is now (in Norm. writing mode):

$$16.2 \pi \cdot 10^3 \text{ div./s} = 100 \text{ div./ms.}$$

3. Persistence-Store control assembly

This assembly, consisting of R18 and SK31, can be checked as follows:

- a. In the "Normal" position, the two outer contacts in front of the front switch deck are connected to each other. The centre contact must be free.
- b. In the "Store" range, the contact at the rear of the front switch deck must be closed.
- c. In the "Variable persistence" range the contact at the rear switch deck must be closed.
- d. In the "Normal" position the resistance between the centre- and the right-hand side contact to the rear potentiometer must be less than 50 ohms (potentiometer seen from rear and contacts pointing downwards). In the position of "Minimum persistence" this resistance must be less than 1200 ohms.

For following sections D.....I of chapter CHECKING AND ADJUSTING refer to the basic PM 3250 (/04) service manual.

PHOTO NO.

1. Adjusting R1977 for minimum rim effects; R1977 in fully counter clockwise position.
2. Same as photo 1, but R1977 in fully clockwise position.
3. Correctly adjusted 'clouds' in Max. Write mode.
4. Correct writing speed in Normal Write mode.
5. Poor writing speed in Normal Write mode . *)
6. Poor writing speed in Max. Write mode; R1946 too far clockwise. *)
7. Exaggerated writing speed in Max. Write mode, the display will bloom-up after some moments; R1946 too far in counter clockwise direction. *)
8. Correct writing speed in Max. Write mode. *)

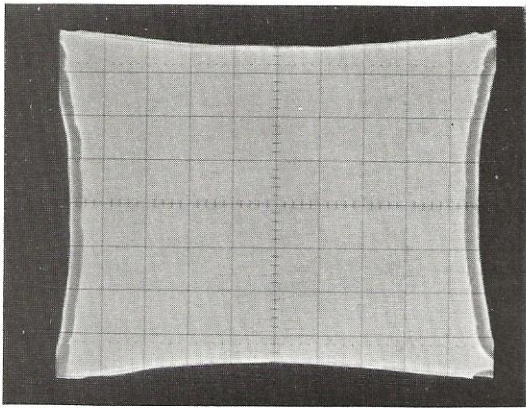
EXPOSURE DATA

All photographs have been taken on Polaroid 3000ASA type 107 film with camera PM 9380 with adaptor PM 9376.

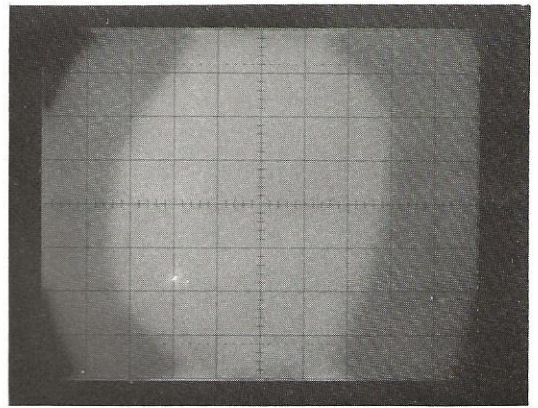
*) Photographs 5...8 have been taken with additional uniform background exposure for easy recognition of graticule and screen format. The additional exposure was taken with the oscilloscope in the minimum persistence mode, intensity knob turned clockwise to full extent, exp. time 1/8 s at F16.

PARTICULAR exposure data

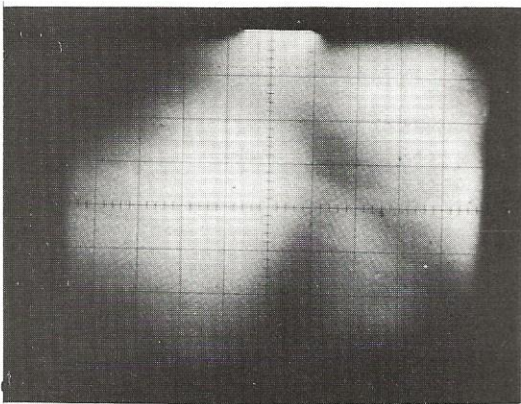
1. 1/30 s F16
2. 1/8 s F16
3. 1/8 s F16
4. 1/30 s F16
5. 1/30 s F16 with additional background exposure
6. 1/30 s F16 with additional background exposure
7. 1/30 s F16 with additional background exposure
8. 1/30 s F16 with additional background exposure



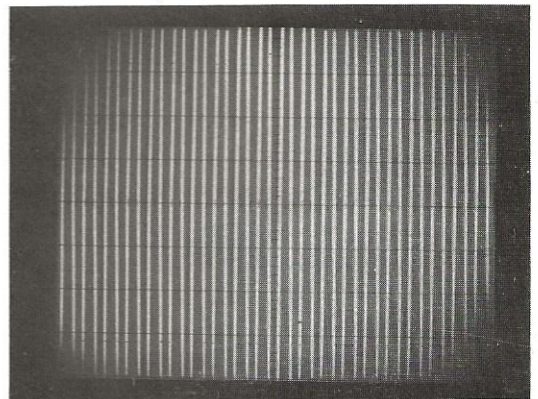
1.



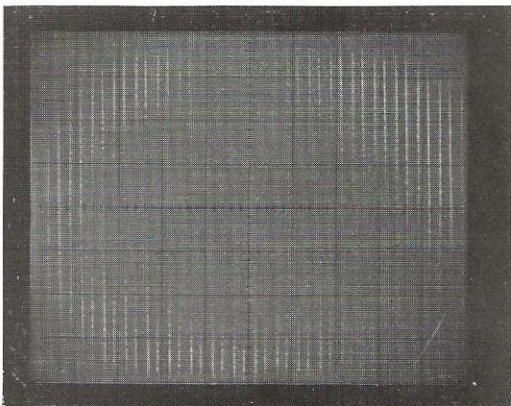
2.



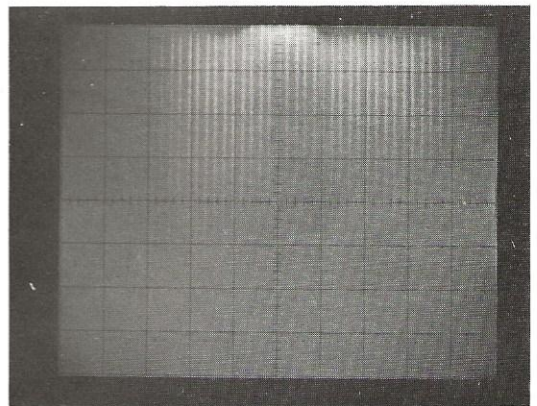
3.



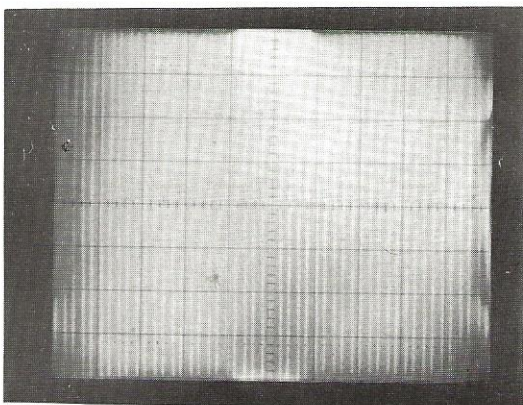
4.



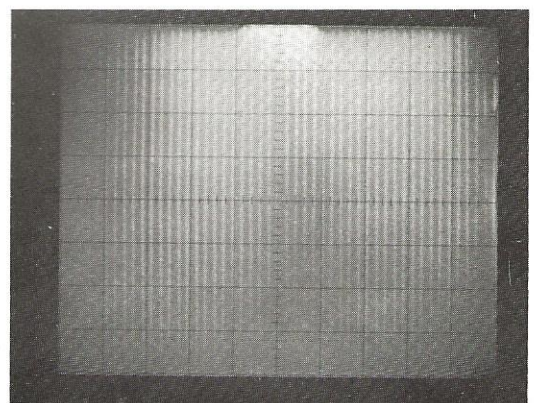
5.



6.



7.



8.

VII. List of parts

Parts which are not listed below can be found in the parts lists of the basic manual PM 3250.

<i>Item</i>	<i>Code number</i>	<i>Description</i>
Mechanical parts		
15	5322 455 84003	Front plate
—	5322 413 30329	Knob SK31/R18
Complete units		
U2	5322 216 54084	Supply panel compl.
U3	5322 216 54082	Z-amplifier panel compl.
U7	5322 216 54083	H.T. chopper unit compl. *)
U23	5322 216 54086	Horizontal output panel compl.
U38	5322 216 54071	Flood-gun filament supply panel compl.
U39	5322 218 64015	H.T. rectifier block
U40	5322 216 54069	Var. persist. and storage control panel compl.

- If unit U26 of the basic PM 3250 is used as replacement in the PM 3251, resistor R561 (18,000 ohms) located under the blue cover plate, must be changed to 5600 ohms (this is to avoid the showing of chopper pulses on the display at higher brightness).
- Calibration unit U9 of the PM 3250 may be used in the PM 3251, however the c.r.t. bleeder chain must be modified; check the values as indicated in the PM 3251 circuit diagram (note that the graticule illumination circuit is not used in the PM 3251).

Semiconductors

Diodes

BY187	5322 130 34136	H.T. diode
BYX45/600R	5322 130 34141	Power supply rectifier diode

Zener diodes

BZX79/C5V6	5322 130 30759
BZX79/C8V2	5322 130 34119
BZX79/C51	5322 130 34166
BZX79/C62	5322 130 34165

Transistors

BD131	5322 130 40752
BF337	5322 130 44037
BSW66	5322 130 40714

*) U8 does not exist in the PM 3251; the components on the basic U8 board have been mounted on U7 of the PM 3251.

<i>Item</i>	<i>Code number</i>	<i>Description</i>
Tubes, Lamps		
B1	5322 131 24012	Storage cathode ray tube L14-110G compl. with coils L1701, L1702
LA5	5322 134 40167	Pilot lamp 5 V type 683
Transformers		
T1201	5322 146 34017	Power supply transformer
T1202	5322 142 64004	H.T. chopper transformer
Switches		
SK13, 29, 30	5322 276 34006	Switch assembly, Beam, Max. Write, Erase
SK31/R18	5322 219 84018	Switch with pot. meter Norm., Persist., Store

POTENTIOMETERS

<i>Item</i>	<i>Code number</i>	Ω	%	<i>W</i>	<i>Remarks</i>
R6	5322 100 20376	1 M	20	0,25	'INTENS'
R7	5322 101 20375	470 k	20	0,25	'FOCUS'
SK31/R18	—	See 'SWITCHES'			
R1733	5322 101 14023	2500	20	0,5	V *)
R1742, 1743	5322 101 14001	1 M	20	0,5	H
R1752	5322 101 20376	1 M	20	0,25	
R1754, 1767	5322 100 10123	50 k	20	0,5	H
R1758	5322 101 20369	47 k	5	0,25	
R1765	5322 100 10114	5 k	20	0,5	H
R1769, 1772	5322 103 20091	4,7 k	5	3	
R1773	5322 103 20094	10 k	5	3	
R1944, 1946	5322 100 10152	25 k	20	0,5	H
R1976, 1977	5322 100 10152	25 k	20	0,5	H
R1986	5322 100 10157	25 k	20	0,5	V

CAPACITORS

<i>Item</i>	<i>Code number</i>	<i>F</i>	%	<i>V</i>	<i>Remarks</i>
C1200	5322 121 20172	220 n	10	250	
C1216	4822 124 20045	80 μ		100	Electrolytic
C1219, 1220	4822 122 31177	470 p	20	4 k	High tension
C1221	5322 122 24001	500 p	-20 +50	9 k	High tension
C1222, 1223	4822 122 31177	470 p	20	4 k	High tension
C1236	4822 121 40079	220 n	10	250	
C1237	4822 121 40042	47 n	10	250	
C1238	4822 124 20423	1500 μ		16	Electrolytic (2 in par.)
C1239	4822 124 20349	6,8 μ		10	Electrolytic
C1701	5322 122 40068	1,2 p	0,25 p	500	
C1703	5322 124 10153	22 μ		15	Tantalum
C1706	4822 124 20059	6,4 μ		150	Electrolytic
C1716	5322 121 40195	33 n	10	1600	
C1717	4822 121 40298	4,7 n	10	1600	
C1723	5322 121 40279	68 n	10	630	
C1727	4822 121 40012	100 n	10	400	
C1728	4822 124 20346	4,7 μ		63	Electrolytic
C1905	4822 124 20364	33 μ		6,3	Electrolytic

*) V - Mounted vertically on p.c. board

<i>Item</i>	<i>Code number</i>	<i>F</i>	<i>%</i>	<i>V</i>	<i>Remarks</i>
C1906	5322 124 20372	47 μ		63	Electrolytic
C1907	5322 124 10083	10 μ		35	Tantalum
C1908	5322 124 10164	3,3 μ		35	Tantalum
C1909	4822 124 20575	100 μ		25	Electrolytic

RESISTORS

<i>Item</i>	<i>Code number</i>	Ω	<i>%</i>	<i>Style</i>
R1179	5322 116 54406	15,4 k	1	MR30
R1194	5322 116 54313	62 k	5	CR37
R1198, 1199	5322 110 60106	910	5	CR25
R1225	4822 122 20134	10 k	5	5,5 W (W.W.)
R1230	4822 110 41158	82 k	5	CR52
R1231	5322 116 54011	5,6 k	2	CR25
R1235	5322 116 54056	187	1	MR25
R1248	4822 110 41143	22 k	5	CR52
R1254	5322 116 50544	866	0.25	MR34E
R1255	5322 116 50482	33,2 k	1	MR25
R1269	5322 116 50578	78,7	1	MR25
R1274	4822 113 60025	0,68	10	2 W
R1275	4822 111 30351	750	5	CR16
R1702	5322 111 30293	180 k	5	CR16
R1703	4822 111 30277	22 k	5	CR16
R1706	5322 111 30124	4,3 k	5	CR16
R1707	4822 111 30265	2,2 k	5	CR16
R1708	4822 111 30331	470	5	CR16
R1709	4822 111 30264	2,7 k	5	CR16
R1711, 1712	5322 116 50818	44,2	1	MR25
R1713	5322 116 50788	332	1	MR25
R1714	5322 116 50581	2,49 k	1	MR25
R1716	4822 111 30352	82	5	CR16
R1717	5322 116 54009	562	1	MR25
R1722	5322 111 34094	620	5	CR16
R1723	4822 111 30324	100	5	CR16
R1724	5322 113 44122	2,7 k	5	WR0825E
R1734	5322 116 50598	13 k	5	CR37
R1736	4822 110 30137	13 k	5	CR52
R1738	4822 111 30327	220	5	CR16
R1744	4822 110 42194	1,8 M	10	CR68
R1746	5322 116 54262	51	5	PR52
R1749	4822 110 42196	2,2 M	10	CR68
R1753	5322 116 50852	40,2 k	1	MR25
R1757	4822 110 53107	1 k	5	CR37
R1759	5322 116 50483	38,3 k	1	MR25
R1762	5322 116 50672	51,1 k	1	MR25
R1763	5322 111 30296	100 k	5	CR16
R1766	5322 116 50852	40,2 k	1	MR25
R1768	4822 110 53096	390	5	CR37
R1774	4822 110 53112	1,5 k	5	CR37
R1901	5322 116 50484	4,64 k	1	MR25
R1902	5322 116 50509	4,87 k	1	MR25
R1903, 1906	5322 116 54012	6,81 k	1	MR25
R1904	5322 116 50556	4,42 k	1	MR25

<i>Item</i>	<i>Ordering number</i>	Ω	%	<i>Style</i>
R1907, 1909	5322 116 50598	13,3 k	1	MR25
R1908	5322 116 54012	6,81 k	1	MR25
R1911	5322 111 30364	20 k	5	CR16
R1912, 1913	5322 111 30306	75 k	5	CR16
R1914	4822 111 30303	8,2 k	5	CR16
R1916	5322 111 30281	39 k	5	CR16
R1917	4822 111 30292	82 k	5	CR16
R1918	4822 111 30324	100	5	CR16
R1919	5322 111 30393	6,2 k	5	CR16
R1921	4822 111 30264	2,7 k	5	CR16
R1922	5322 111 44143	51 k	5	CR16
R1923	5322 111 30281	39 k	5	CR16
R1924	5322 111 30279	33 k	5	CR16
R1927	4822 111 30308	120 k	5	CR16
R1928	5322 111 30296	100 k	5	CR16
R1929, 1931	5322 111 30288	47 k	5	CR16
R1932	4822 111 30349	5,1 k	5	CR16
R1933	5322 111 34092	3 k	5	CR16
R1935	5322 111 44144	11 k	5	CR16
R1936	5322 111 44145	62 k	5	CR16
R1937	4822 111 30303	8,2 k	5	CR16
R1938, 1939	5322 111 30281	39 k	5	CR16
R1940	5322 111 30295	24 k	5	CR16
R1941	5322 111 30281	39 k	5	CR16
R1942	4822 111 30275	15 k	5	CR16
R1943	5322 111 30277	22 k	5	CR16
R1945	5322 116 50635	1,47 k	1	MR25
R1947	5322 111 30258	390 k	10	CR16
R1948	4822 111 30308	120 k	5	CR16
R1949	5322 111 30295	24 k	5	CR16
R1950	5322 116 50875	59 k	1	MR25
R1951	4822 111 30332	680 k	10	CR16
R1952	4822 111 30292	82 k	5	CR16
R1953, 1954	4822 111 30257	330 k	10	CR16
R1955	5322 111 30289	56 k	5	CR16
R1956	5322 111 30306	75 k	5	CR16
R1958	5322 111 44144	11 k	5	CR16
R1959	5322 111 30256	270 k	10	CR16
R1961	4822 111 30332	680 k	10	CR16
R1962	5322 111 30281	39 k	5	CR16
R1963	5322 111 30305	36 k	5	CR16
R1966, 1967	5322 111 30302	220 k	10	CR16
R1968	5322 111 30281	39 k	5	CR16
R1969	4822 111 30273	10 k	5	CR16
R1971	4822 111 30264	2,7 k	5	CR16
R1978	5322 116 50593	1,62 k	1	MR25
R1982	4822 111 30312	4,7 k	5	CR16
R1984	5322 111 30402	7,5 k	5	CR16

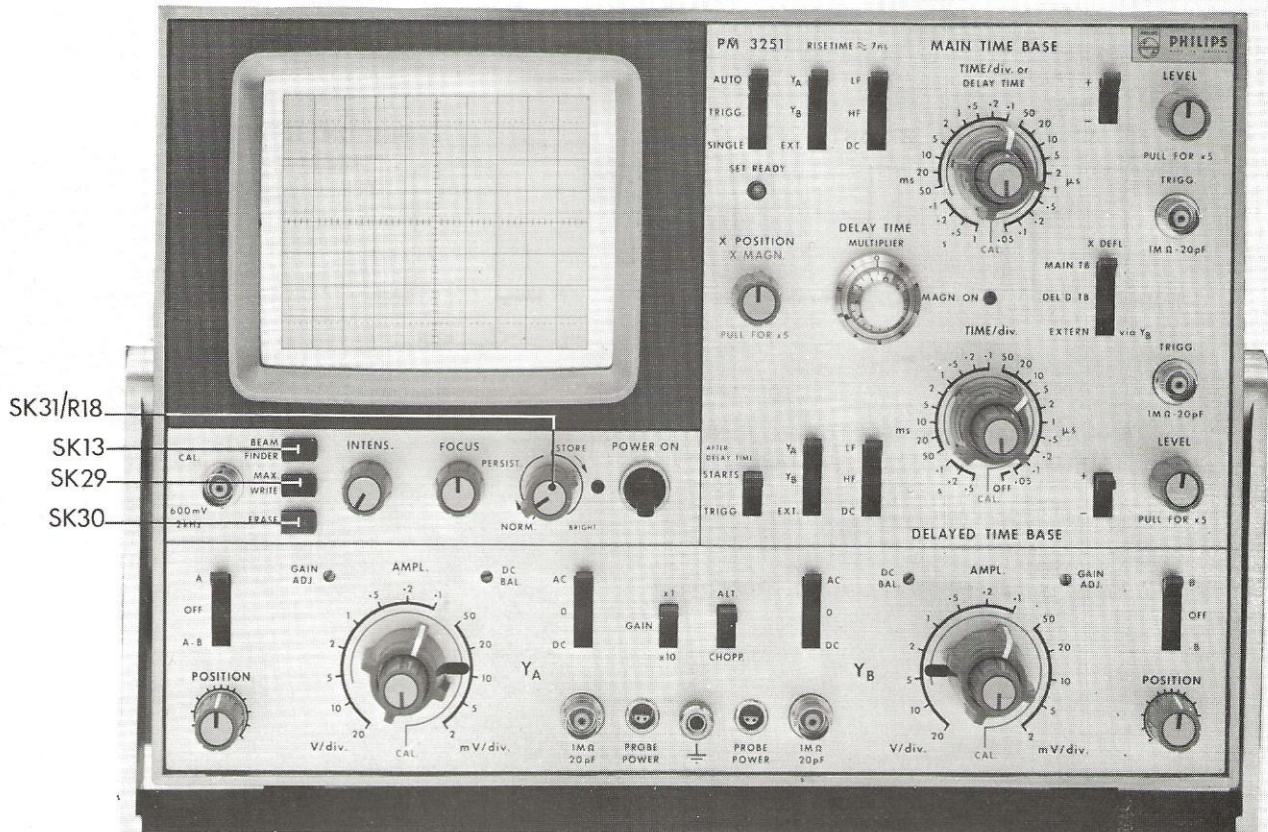


Fig. 1. Front view

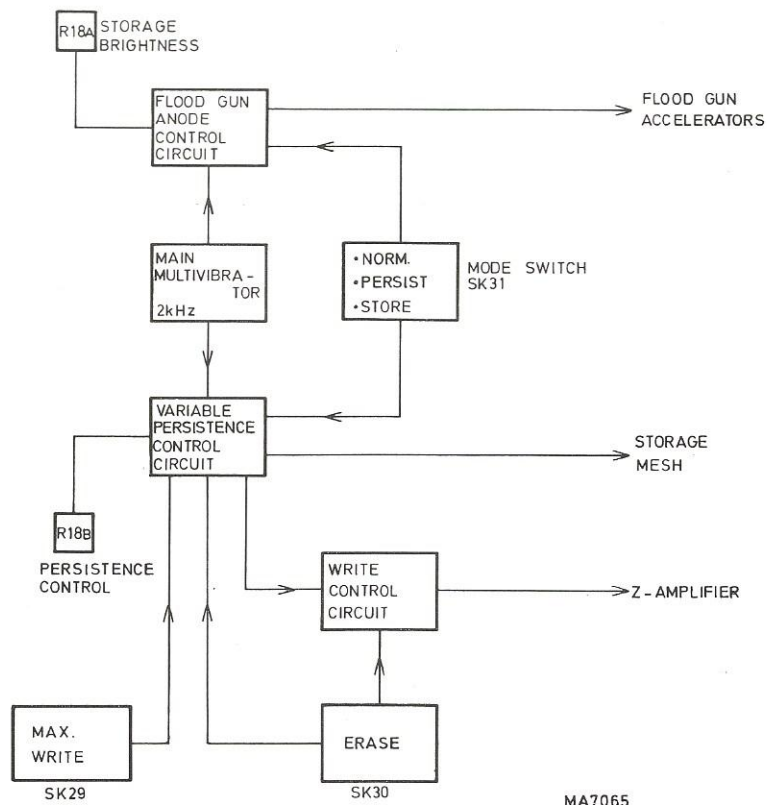


Fig. 2. Block diagram of storage and persistence control circuit

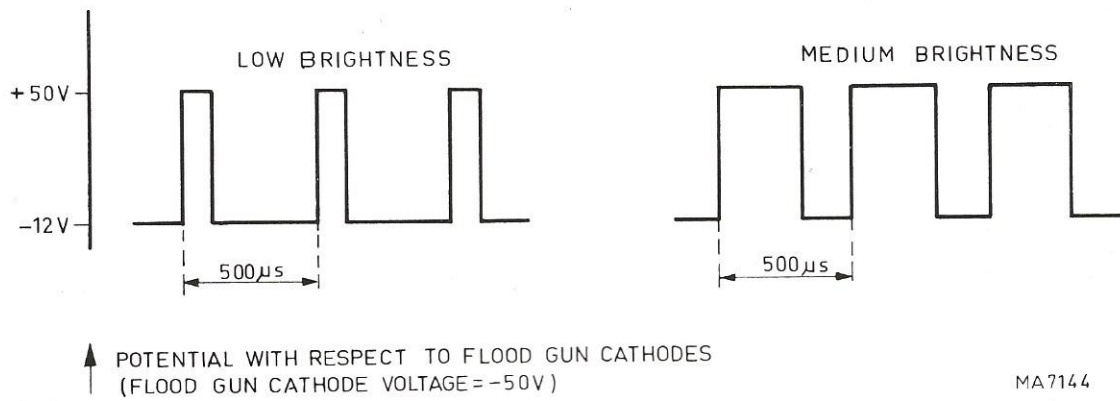


Fig. 3. Flood gun accelerators pulse in 'Store' mode

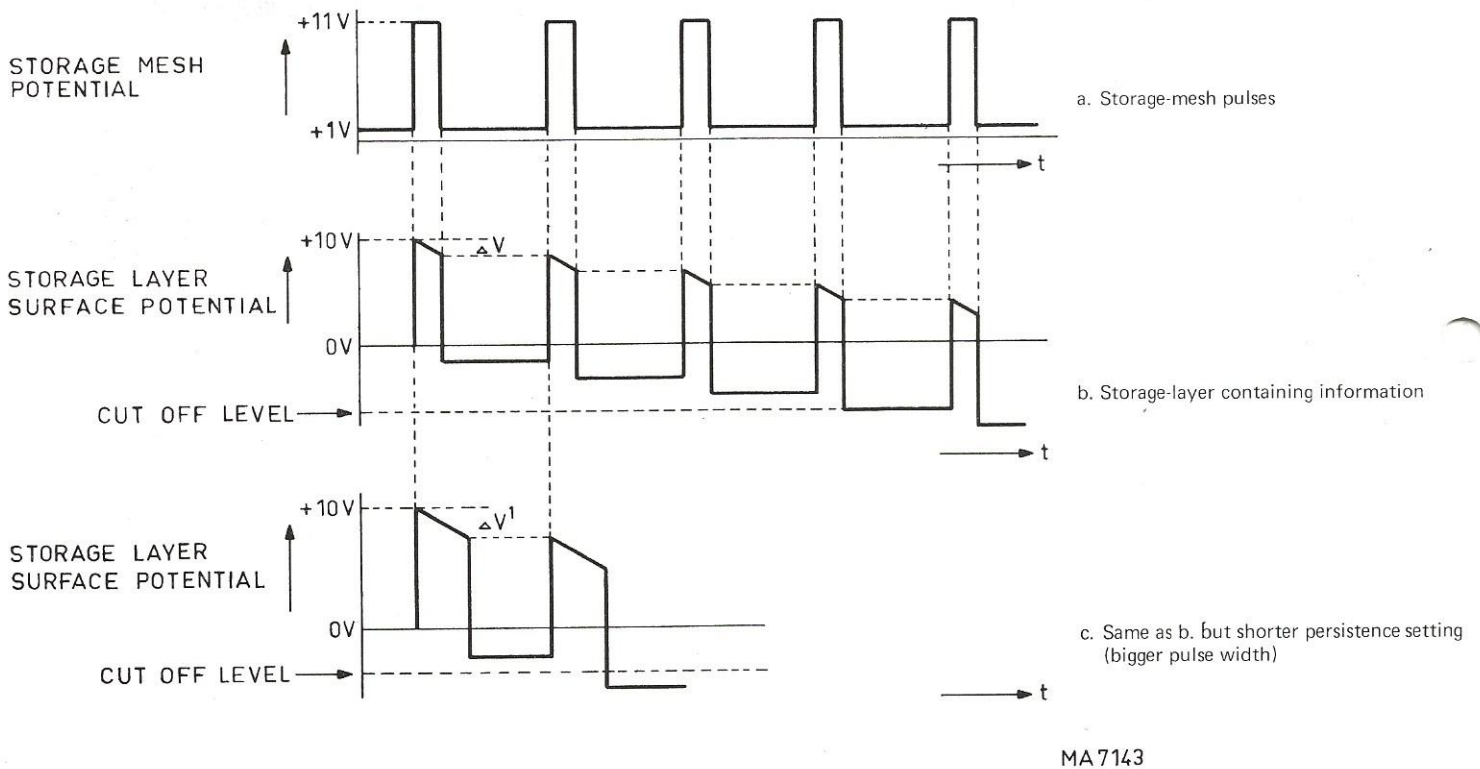


Fig. 4. Variable persistence pulses

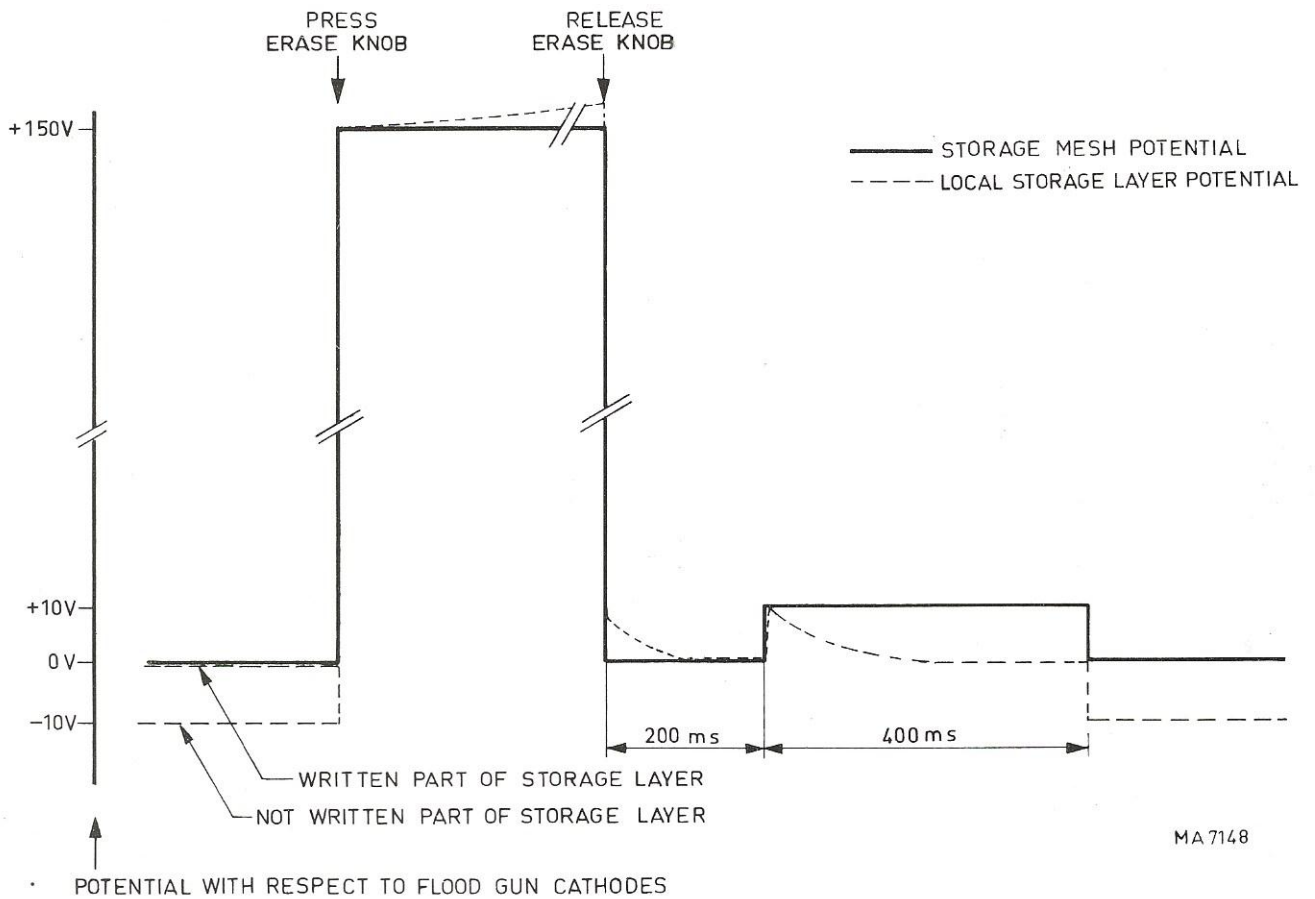


Fig. 5. Erase pulse

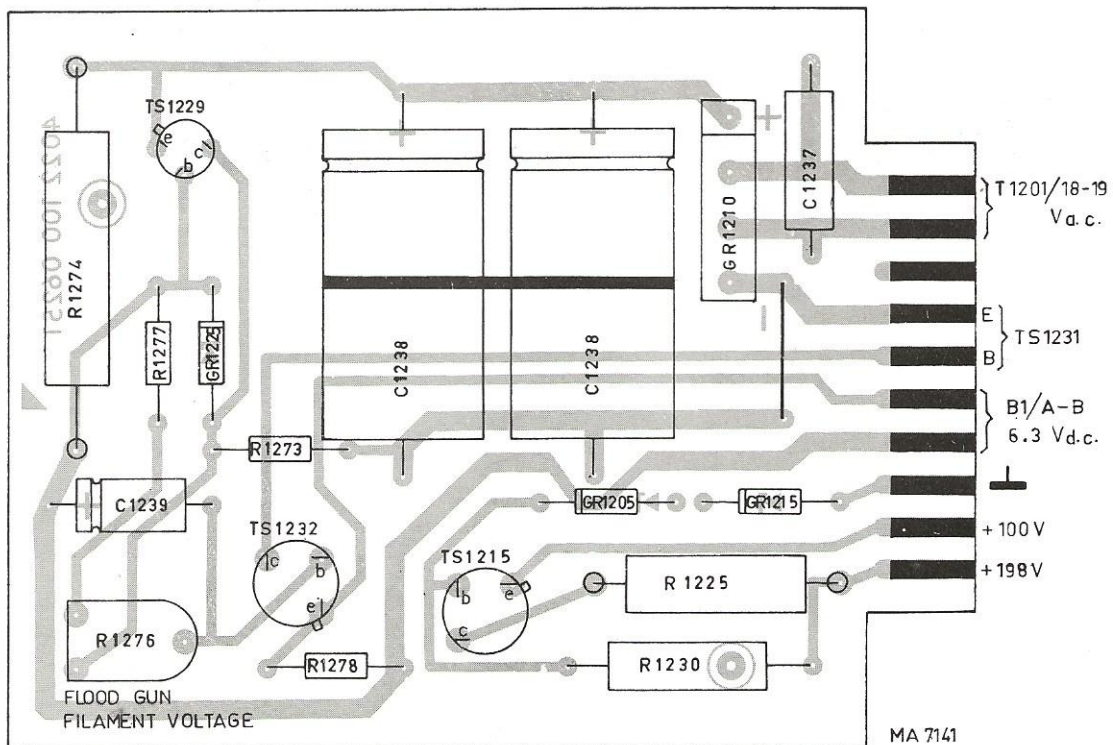
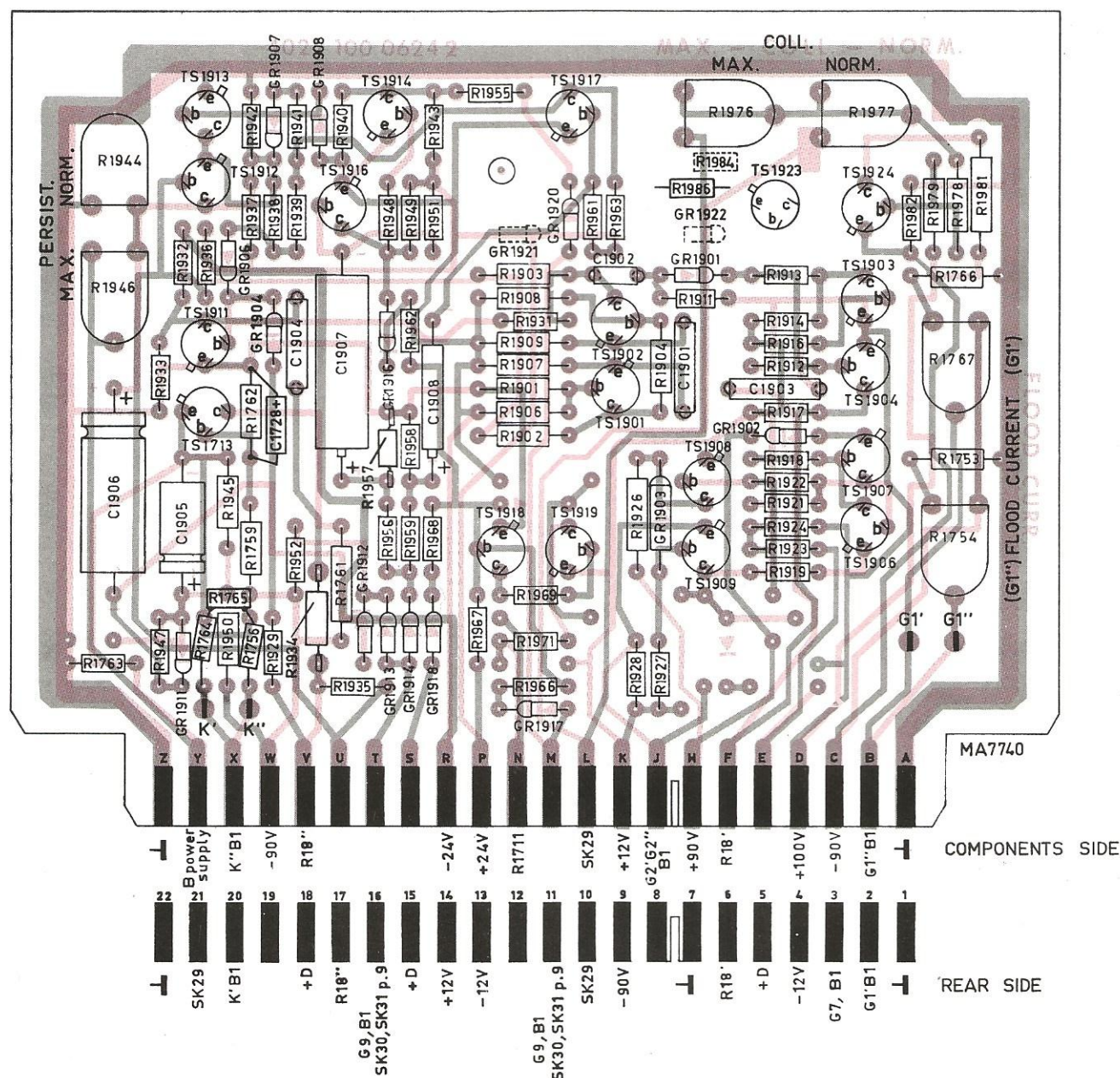
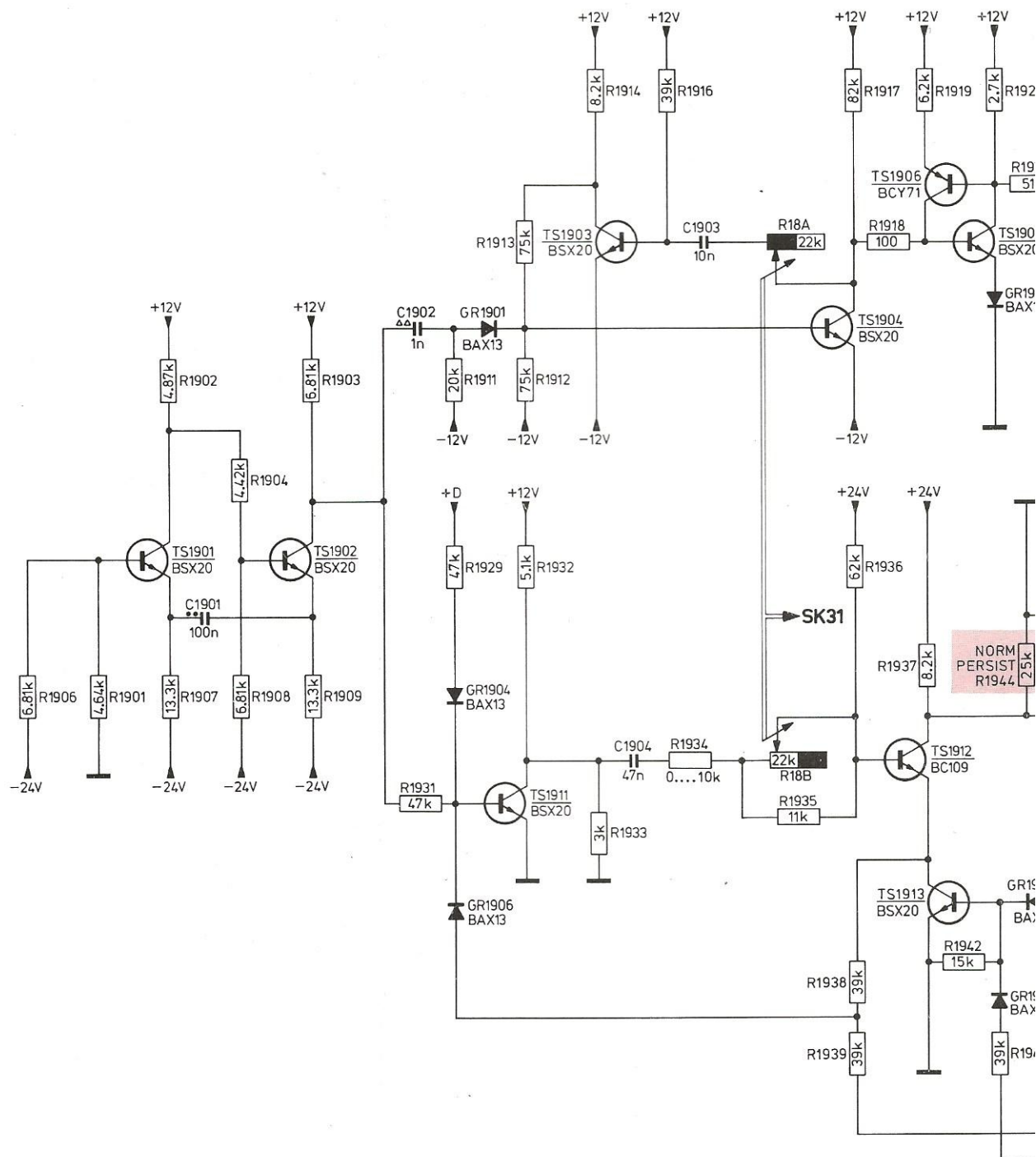
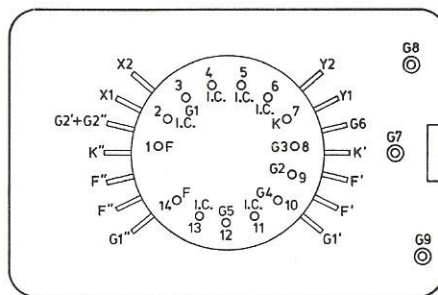


Fig. 6. Flood gun filament and +100 V supply unit (U38)





COLORS SIDE-CONNECTIONS CRT		
X2	ORANGE	Y2
X1	YELLOW	Y1
G2'+G2"	ORANGE	G6
K"	BROWN	K'
F"	PURPLE	F'
F"	WHITE	F'
G1"	RED	G1'



REAR VIEW L14-110GH

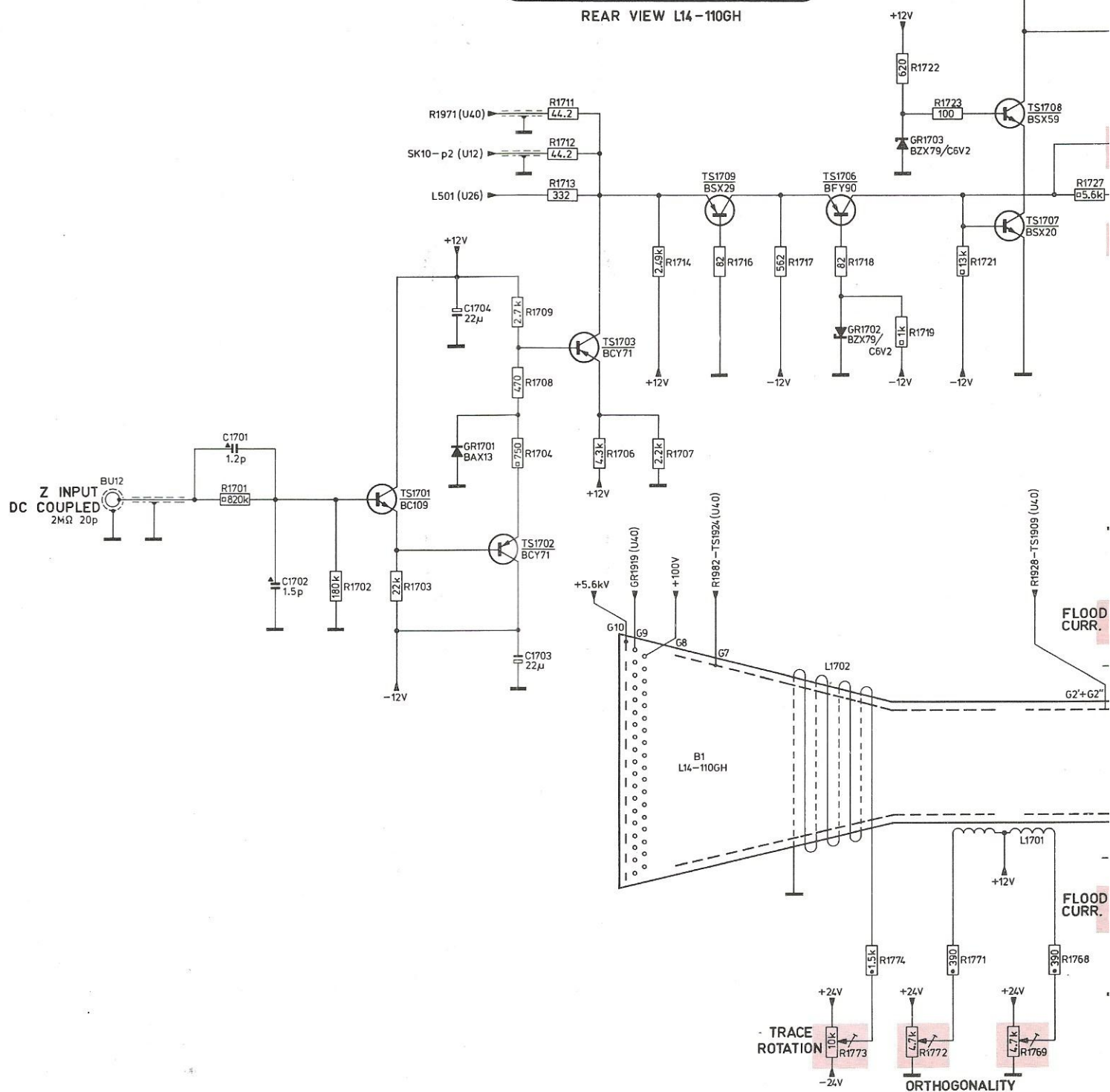
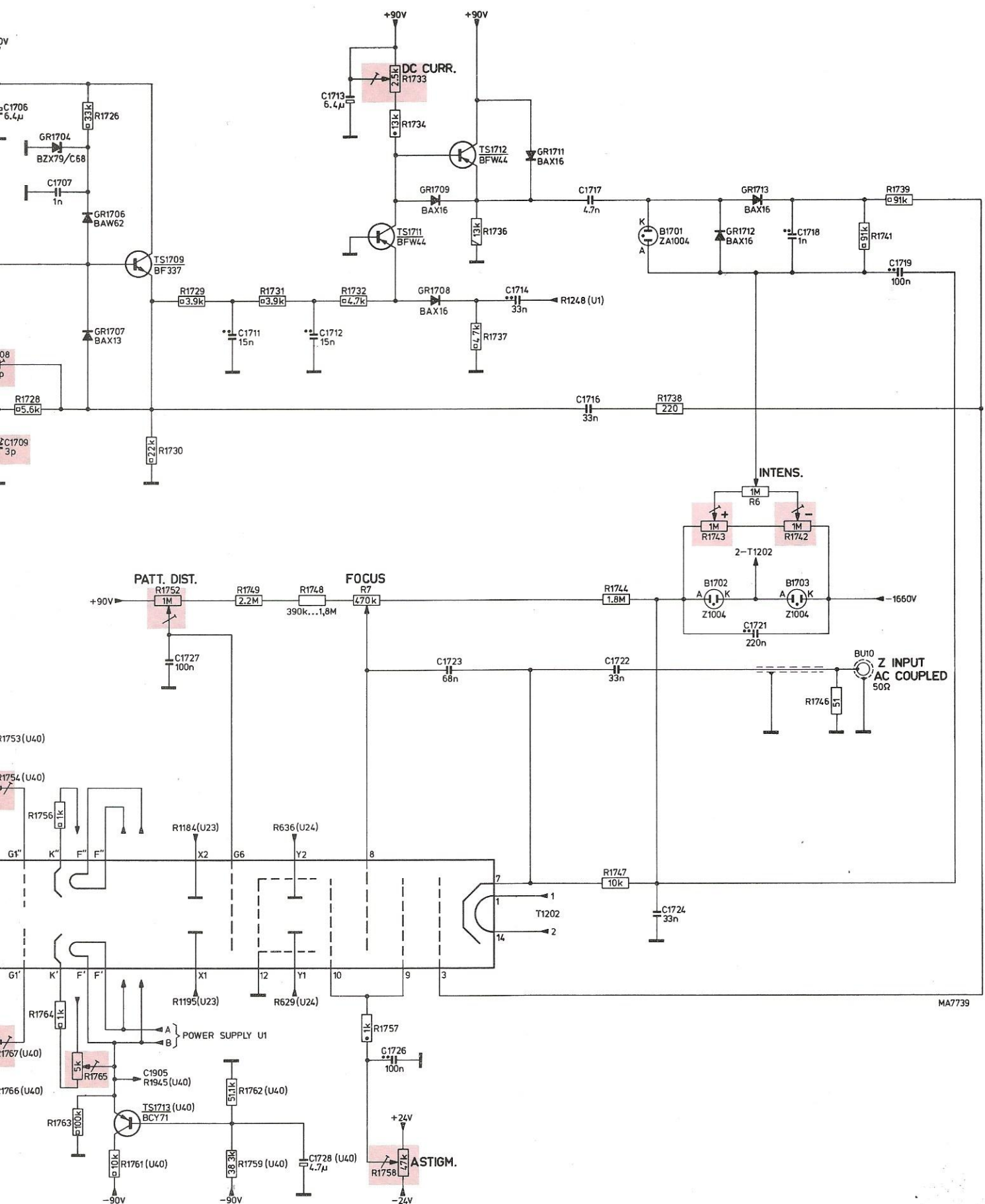
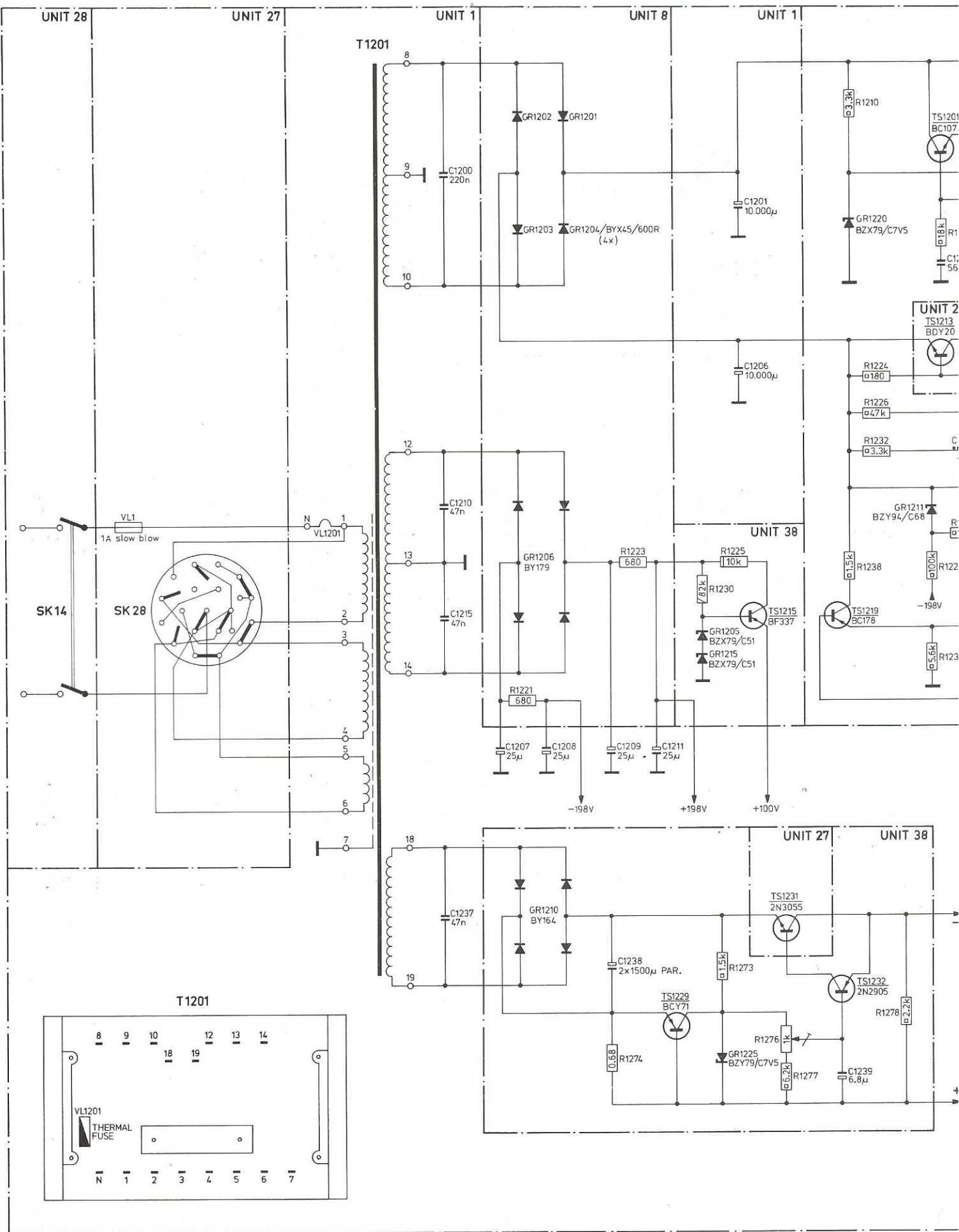


Fig. 9. Circuit diagram c.r.t. and unblanking unit







MA7657

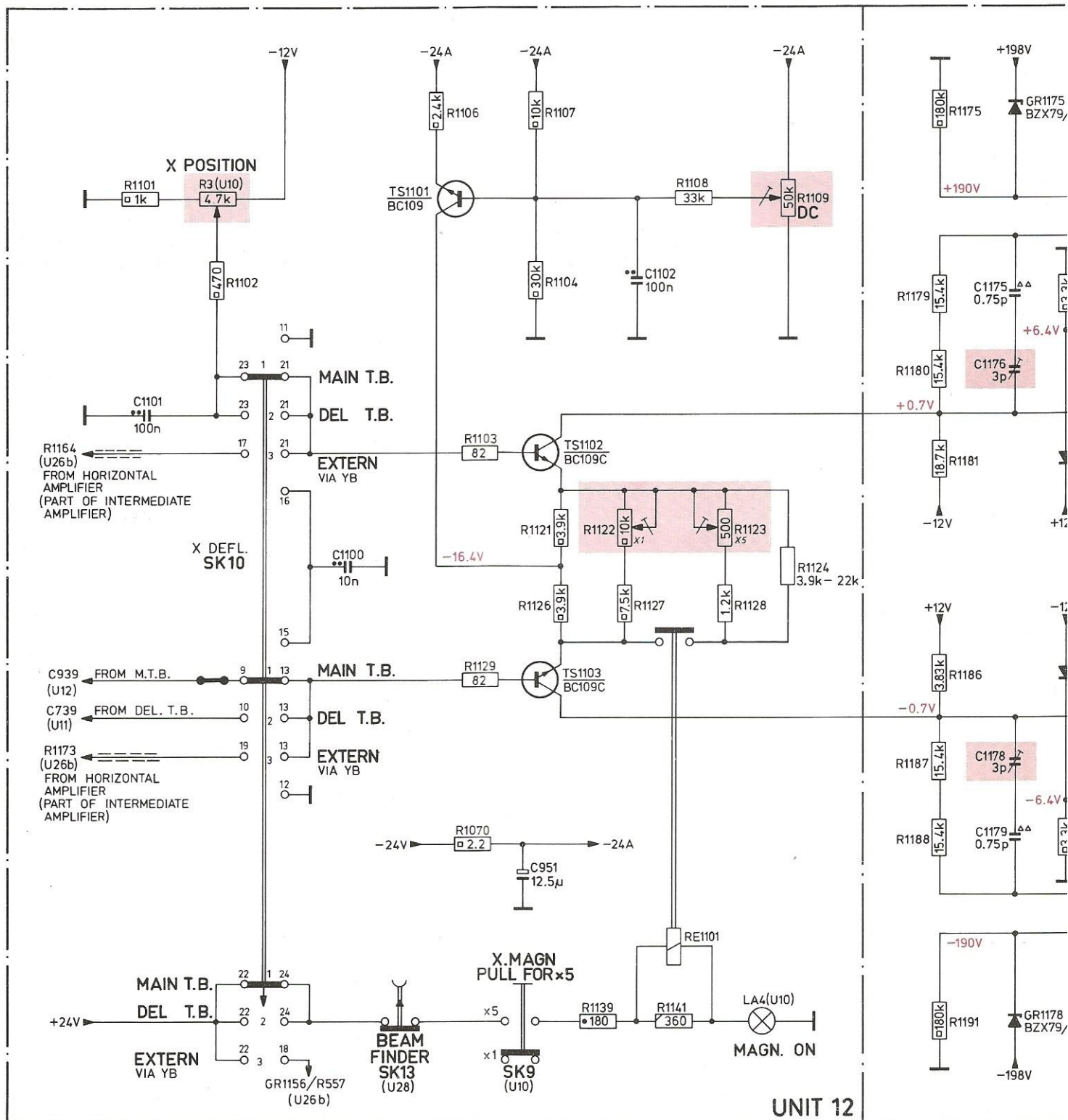
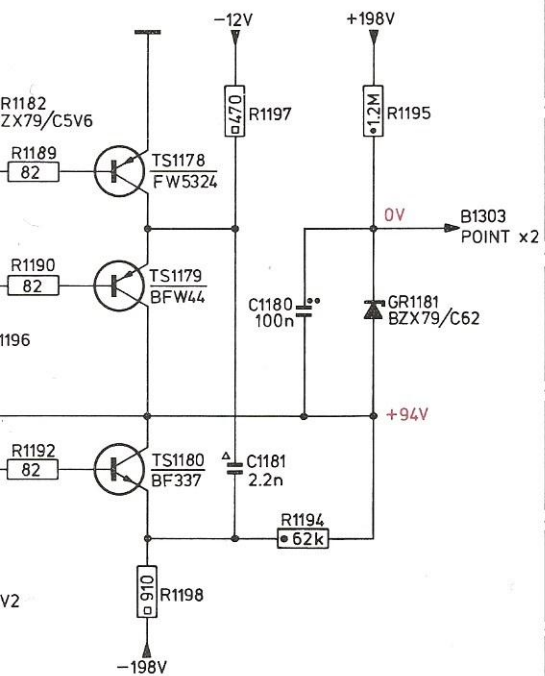
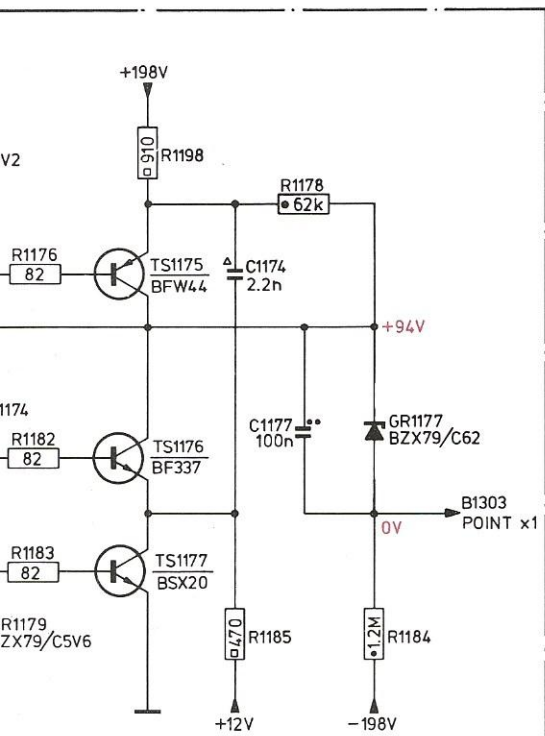


Fig. 11. Circuit diagram final X amplifier



UNIT 23

MA7768